THE THEORY OF NUCLEAR FORCES

BY

HERBERT ARNOLD NYE

A.B., Allegheny College, 1936

A.M., University of Illinois, 1938

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
PHYSICS IN THE GRADUATE SCHOOL OF
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THE THEORY OF NUCLEAR FORCES

In Part A the cross section for the photo-electric disintegration of the deuteron by 17.5 Mev gamma-rays has been calculated using the neutron-proton potentials, based on a neutral mesotron theory, given by Bethe[1]. The computations yield a total cross section of 5.4×10^{-28} cm^2 and an angular distribution of the ejected particles with respect to the direction of the incident gamma-rays of $\sin^2\Theta + 0.26$. These values are determined by the shape of the neutron-proton wave functions, which should not be essentially different for a charged mesotron theory, and hence the results indicate that the conclusion of Fröhlich, Heitler, and Kahn[2], based on an inconsistent calculation, that the exchange nature of the neutron-proton interaction implies a cross section considerably larger than that obtained by older and more simple theories, is false.

In Part B the multiple scattering of electrons of cosmic ray energies is discussed for the purpose of obtaining information on the spreading of cosmic ray showers. The lateral and directional extension of a beam of electrons originally moving in the direction of the z axis after passage through a thickness of matter z is given by the distribution

$$f(r,\Theta,\phi) = \frac{3}{2\pi D^2 z^4} \exp\left(-\frac{3r^2}{Dz^3} - \frac{\Theta^2}{Dz} + \frac{3\Theta r\cos\phi}{Dz^2}\right),$$

where r measures the distance from the z axis, Θ gives the angle of the velocity vector with that axis, ϕ is the relative azimuth of r and the velocity vector, and D is of the nature of a reciprocal mean free path.

[1] H. A. Bethe, Phys. Rev. **57**, 390 (1940).

[2] H. Fröhlich, W. Heitler, and B. Kahn, Proc. Roy. Soc. **A174**, 85 (1940).

VITA

Herbert Arnold Nye was born at Sharon, Pennsylvania, on June 19, 1914. He received his elementary schooling in the public schools of that city. In 1936 he received the degree of Bachelor of Arts from Allegheny College, and in 1938 the degree of Master of Arts from the University of Illinois. From 1936 to 1940 he was a teaching assistant at the University of Illinois, and for the year 1940-41 has been a University Fellow.

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